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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/689,617	10/22/2003	Satoru Okamoto	12732-170001	4799
26171 7590 08/03/2009 FISH & RICHARDSON P.C. P.O. BOX 1022 MINNEAPOLIS, MN 55440-1022				
EXAMINER DAHIMENE, MAHMOUD				
ART UNIT 1792		PAPER NUMBER		
NOTIFICATION DATE 08/03/2009		DELIVERY MODE ELECTRONIC		

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

PATDOCTC@fr.com

Office Action Summary

Application No.

10/689,617

Applicant(s)

OKAMOTO, SATORU

Examiner

MAHMOUD DAHIMENE

Art Unit

1792

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 16 April 2009.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-95 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-95 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO/SF/ICE)
Paper No(s)/Mail Date _____
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claims 1, 8, 29, 36, 57, 64, 71, 78, 85, and all dependent claims are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. In the above claims the term "BO_x" is not enabling because there is no sufficient direction or guidance in the claim or the specification to determine which "BO_x" is cleaned by the plasma. The only definition of the term "BO_x", in applicant's specification is found in page 8, second paragraph, citing "BCI.sub.3 is used as an etching gas for Al and Ti. It is mainly used in etching for wirings made of Al that provide electrical connections to TFTs. The applicants of the invention conjectured that **BO.sub.x** compounds, such as **B.sub.2O.sub.3**, adhering to a quartz surface, which is employed within a chamber of the etching apparatus, when BCI.sub.3 is used as an etching gas, will interfere with plasma reactions by exciting or dissociating an etching gas used during subsequent processes". In the above definition "x" is never defined in the claims or in the specifications. In addition "**BO.sub.x** compounds, such as **B.sub.2O.sub.3**" is not a

correct statement because **B.sub.2O.sub.3 (or B₂O₃)** is not even a **BO.sub.x (or BO_x)**. **BO.sub.x (or BO_x)** has only one B (boron) atom in the molecule, whereas **B.sub.2O.sub.3 (or B₂O₃)** has two.

3. In addition there is no working example where a **BO.sub.x (or BO_x)**, with a defined x, is presented.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 1, 8, 29, 36, 57, 64, 71, 78, 85, and all dependent claims are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. It is not clear what specific compound of the group **BO.sub.x (or BO_x)** is claimed by the applicant since "x" is not defined in the claims or the specification.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-7, 15-21, 57-95 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chow et al. (US 6,872,322) in view of Lui et al. (US 6,566,270), Wolf

(Silicon Processing for the VLSI Era, Volume 4- Deep Submicron Process Technology, Lattice Press, 2002, page 11), Choi et al. (US 2003/0207585) and Nakajima et al. (2002/0053674).

Regarding claim 1, Chow discloses a method for cleaning a chamber with a plasma including the steps of: forming a polysilicon/semiconductor film over a substrate and a tungsten silicide /conductive layer over the semiconductor film (col. 11, lines 1-3); filling a chamber with Cl₂ and generating plasma from the Cl₂ to clean the chamber (col. 11, lines 35-42); placing the wafer/substrate with the polysilicon/semiconductor film and a tungsten silicide/conductive layer in the chamber being cleaned with added cleaning gas/cleaned chamber to etch the conductive film in the cleaned chamber by repeating the etching steps (col. 10, lines 52-57; col. 11, lines 1-20; fig. 3).

Chow discloses forming a silicon oxide layer under the polysilicon and tungsten layers (col 8, lines 15-17). The oxide layer of Chow is a gate oxide deposited on top of a semiconductor film which forms the channel underneath the gate, as anyone with ordinary skill in the art would know that the semiconducting channel is formed on a "first" substrate. It is noted that Chow is silent about the formation of the transistor channel including the oxide layer being deposited on a conductive layer, however Wolf teaches p-wells or n-wells are conventionally used in device formation see figure 1-7 of Wolf (page 11). One of ordinary skill in the art would have been motivated to use p-wells or n-wells in order to form a twin-well CMOPS structure as suggested by Wolf.

Chow discloses the use of dummy wafers/substrates for seasoning the chamber, however, It is noted that Chow is silent about using a second substrate which is not to form a device (conventionally known as a dummy substrate) for cleaning the chamber.

Lui discloses dummy substrates are conventionally used for etch chamber cleaning (column 1, line 33).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Chow to use a dummy substrate because dummy substrates are conventionally used for etch chamber cleaning. One of ordinary skill in the art would have been motivated to use a dummy substrate in order to decouple the process of chamber cleaning from the process of etching when the substrate is sensitive to the cleaning byproducts. One of ordinary skill in the art would have been motivated to modify the method of Chow by performing cleaning independently of the etching step when the cleaning process result in undesirable effects on the substrate such as contamination or uncontrollable etch, the method of Chow could obviously be extended to process more delicate substrates, by performing independent etch and clean steps. Lui teaches cleaning the chamber using a dummy wafer on the chuck while cleaning.

Applicant does not specify what specific kind of etching is performed, it would appear that the chamber cleaning procedure and the etch step of Chow would be effective regardless of whether an insulating layer is present under the conducting layer or not, etching is usually performed on the topmost layer. It would also appear obvious to one of ordinary skill in the art at the time the invention was made that the sequence of

layers positioned below the topmost layers of conductive films would not affect the chamber cleaning step since those layers are not exposed to the cleaning environment. Chow teaches the general concept of chamber cleaning for the purpose of increasing etch selectivity by reducing the concentration of unwanted species released from deposits on the chamber walls from a previous etch process performed within the same chamber.

It is noted that Chow is silent with respect to removing BO_x from an inner surface of the chamber, however, Chow suggests etching with BCl₃ and O₂ gases (column 8, line 45). The reference of Chow appears to encompass formation of BO_x since BO_x is a deposition byproduct of BCl₃ and O₂ gases when combined in the plasma, which is removed since Chow is silent about any BO_x residues after the cleaning step.

It is noted that Chow is silent about cleaning the chamber between a first shape etching and a second shape etching.

Nakajima teaches two step etching of conductive layers is conventionally performed on semiconductor devices (paragraph 0021).

Choi teaches "In one example of the prior art, etching of the silicon nitride layer 106 is carried out using a complicated combination of etch steps, **including a process chamber cleaning step between a first etch step and a second etch step.** The process chamber cleaning step is designed to remove etch byproducts which build up on process chamber walls between the first (physical-type) etch step and the second (chemical-type) etch step." (paragraph 0007). The reference of Choi is not relied on to teach silicon nitride etching but it is relied on to teach **a process chamber cleaning**

step between a first etch step and a second etch step of the same layer is conventionally used in the art of etching.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Chow to clean the chamber after any etching step including a first shape etching and a second shape etching because Choi teaches cleaning after etching is desirable. One of ordinary skill in the art would have been motivated to clean after each etching step in order to avoid accumulation of harmful contaminants on the chamber walls.

Regarding claim 2, Chow discloses using an ICP etching method (col 6, lines 35-40)

Regarding claim 3, Chow discloses that the fluorine gas is CF_4 (col 9, lines 37-40),

As to claim 4, it is noted that Chow is silent about a glass or quartz dummy wafer for the cleaning step, however, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Chow to use a dummy substrate made of any material including glass or quartz which is compatible with the chamber and process chemistry because a dummy wafer is used only during cleaning. One of ordinary skill in the art would have been motivated to use glass or quartz in order to prevent introducing impurities in the chamber since glass or quartz (SiO_2) is conventionally used as a material for material fill or gate material, also quartz is resistant to the cleaning chemistry, and glass or quartz wafers are readily available as dummy wafers.

Regarding claims 5, Chow discloses adding oxygen gas to the cleaning plasma (col 9, lines 37-40), and cites "The present process allows etching of one or more layers on a substrate 25 and simultaneous cleaning of the plasma etching chamber 30 in which the etching process is performed, without stopping the etching process. In one or more of the etch process stages, a cleaning gas is added to the etchant gas in a volumetric ratio selected so that the etching residue formed in any one of the etching stages; or the residue formed in all of the etching stages is substantially entirely removed during the etching process. The etchant gas comprises one or more of Cl.sub.2, N.sub.2, O.sub.2, HBr, or He--O.sub.2 ; and the cleaning gas comprises one or more of NF.sub.3, CF.sub.4, or SF.sub.6. It has been discovered that combinations of these gases provide unique and unexpected etching and cleaning properties" (column 9, lines 1-14). Chow teaches that it has been discovered that combinations of these gases provide unique and unexpected etching and cleaning properties. It would have been obvious to one of ordinary skill in the art at the time the invention was made to remove the etching component of the gas mixture during cleaning step while keeping the cleaning component of the gas mixture.

As to claim 7, fig. 1d of Chow shows an island shaped semiconductor structure is formed.

As to claim 6, quartz is a well known material used in etch chambers. Chow discloses The enclosed chamber 30 has sidewalls 45 and a bottom wall 50 fabricated from any one of a variety of materials including metals, ceramics, glasses, polymers, and composite materials (column 5, line 25). Glasses include quartz.

Regarding Claims 15-21, the references of Chow, Lui , Nakajima , Choi and Wolf have been discussed above.

Chow discloses a method for cleaning a plasma etching chamber comprising the steps of:

placing a substrate having a conductive film of tungsten silicide within a chamber (col 11, lines 1-3),

cleaning the chamber with a plasma generated from Cl_2 , etching the conductive film within the cleaned chamber by repeating the etching step (col 10, lines 52-57; col 11, lines 1-20; fig. 3), Chow discloses that the fluorine gas is CF_4 (col 9, lines 37-40)

Chow discloses forming a silicon oxide layer under the polysilicon and tungsten layers (col 8, lines 15-17).

Chow discloses forming a silicon oxide layer under the polysilicon and tungsten layers (col 8, lines 15-17). The oxide layer of Chow is a gate oxide deposited on top of a semiconductor film which forms the channel underneath the gate, as anyone with ordinary skill in the art would know that the semiconducting channel is formed on a "first" substrate. It is noted that Chow is silent about the formation of the transistor channel including the oxide layer being deposited on a conductive layer, however Wolf teaches p-wells or n-wells are conventionally used in device formation see figure 1-7 of Wolf (page 11). One of ordinary skill in the art would have been motivated to use p-wells or n-wells in order to form a twin-well CMOS structure as suggested by Wolf.

It is noted that Chow discloses the use of dummy wafers/substrates for seasoning the chamber, however, Chow is silent about using a second substrate which

is not to form a device conventionally known as a dummy substrate for cleaning the chamber.

Lui discloses dummy substrates are conventionally used for etch chamber cleaning (column 1, line 33).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Chow to use a dummy substrate because dummy substrates are conventionally used for etch chamber cleaning. One of ordinary skill in the art would have been motivated to use a dummy substrate in order to decouple the processes of chamber cleaning from etching when the substrate is sensitive to the cleaning byproducts. One of ordinary skill in the art would have been motivated to modify the method of Chow by performing cleaning independently of the etching step when the two processes result in undesirable effects on the substrate such as contamination or uncontrollable etch, the method of Chow could obviously be extended to process more delicate substrates, by performing independent etch and clean steps.

Applicant does not specify details on the kind of etching performed in applicant's claim 15, it would appear that the chamber cleaning procedure and the etch step of Chow would be effective regardless of whether an insulating layer is present under the conducting layer or not, etching is usually performed on the topmost layer. It would also appear obvious to one of ordinary skill in the art at the time the invention was made that the sequence of layers positioned below the topmost layers of conductive films would

not affect the chamber cleaning step since those layers are not exposed to the cleaning environment.

Regarding claim 16, Chow discloses using an ICP etching method (col 6, lines 35- 40)

Regarding claim 17, Chow discloses that the fluorine gas is CF₄ (col 9, lines 37-40)

The limitation of claim 18 has been discussed above

Regarding claim 19, Chow discloses adding oxygen gas to the cleaning plasma (col 9, lines 37-40)

Regarding claim 21, Chow discloses using an etching gas mixture of Cl₂, SF₆ and oxygen (col 9, lines 36-51)

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1, 2, 4, 5, 7, 8, 9, 11, 12, 13, are rejected under 35 U.S.C. 103(a) as being unpatentable over Hoefer et al. (US 2003/0222306) in view of Yeh et al. (US 2002/0162827), Nakajima et al. (2002/0053674) and Choi et al. (US 2003/0207585).

Regarding Claims 1, 2, 5, 7, 8, 9, 11, 12, Hoefer discloses a method for manufacturing a semiconductor device, the method comprising: forming a

semiconductor film (18) over a first substrate; forming an insulating film (32) over the semiconductor film; forming a conductive film (34) over the semiconductor insulating film; the conductive layer is etched (figure 4 to figure 5).

It is noted Hoefer is silent about cleaning a chamber, the cleaning including comprising: placing a second substrate in the chamber, wherein said second substrate is not to form a semiconductor device; filling the chamber with a cleaning gas, said cleaning gas comprising Cl_2 or a mixed gas of Cl_2 and a fluorine-based gas; and generating plasma from the cleaning gas; placing the first substrate with the conductive film, the insulating film and the semiconductor film in the cleaned chamber; and etching the conductive film in the cleaned chamber.

Yeh teaches a conductive etch chamber cleaning method wherein "The method further comprises the step of generating a plasma by applying RF energy to the first and second cleaning process gases, such as oxygen and chlorine gases, If there is a sacrificial substrate (also known as a dummy wafer) positioned on the substrate holder 118 to protect the holder 118 from damage during the plasma cleaning operation, the power applied to the second electrode can be set between about 100 W and about 250W. Thus, the method is feasible at the wafer/waferless condition. The method further comprises the step of evacuating the first cleaning process gas from the chamber 100 between the first and the second time periods while maintaining the plasma" (paragraph 0027).

It is noted that Hoefer fails to disclose cleaning includes removing BOx from an inner surface of the chamber, however, Hoefer suggest the substrate the substrate

contains layers including boron (paragraph 0014) and oxygen (paragraph 0018), The reference of Hoefler appears to encompass formation of BO_x since BO_x is a deposition byproduct of boron and O₂ elements when combined in the plasma.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Hoefler by including a chamber cleaning step as described by Yeh because chamber cleaning with a dummy wafer is conventionally used in the art of conductor etch. One of ordinary skill in the art would have been motivated to include a chamber cleaning step as described by Yeh in order to achieve high yield and maintain throughput.

It is noted that Hoefler is silent about cleaning the chamber between a first shape etching and a second shape etching. However, Nakajima teaches two step etching of conductive layers is conventionally performed on semiconductor devices (paragraph 0021). Choi teaches "In one example of the prior art, etching of the silicon nitride layer 106 is carried out using a complicated combination of etch steps, **including a process chamber cleaning step between a first etch step and a second etch step**. The process chamber cleaning step is designed to remove etch byproducts which build up on process chamber walls between the first (physical-type) etch step and the second (chemical-type) etch step." (paragraph 0007). The reference of Choi is not relied on to teach silicon nitride etching but it is relied on to teach **a process chamber cleaning step between a first etch step and a second etch step** of the same layer is conventionally used in the art of etching.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Hoefer to clean the chamber after any etching step including a first shape etching and a second shape etching because Choi teaches cleaning after etching is desirable. One of ordinary skill in the art would have been motivated to clean after each etching step in order to avoid accumulation of harmful contaminants on the chamber walls.

As to claims 4,13, it is noted that Hoefer is silent about a glass or quartz dummy wafer for the cleaning step, however, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Hoefer to use a dummy substrate made of any material including glass or quartz which is compatible with the chamber and process chemistry because a dummy wafer is used only during cleaning. One of ordinary skill in the art would have been motivated to use glass or quartz in order to prevent introducing impurities in the chamber since glass or quartz (SiO_2) is conventionally used as a material for gate material, also quartz is resistant to the cleaning chemistry, and glass or quartz wafers are readily available as dummy wafers.

Claim Rejections - 35 USC § 103

Claims 3, 6, 10, 14, are rejected under 35 U.S.C. 103(a) as being unpatentable over Hoefer et al. (US 2003/0222306) in view of Nakajima et al. (2002/0053674), Yeh et al. (US 2002/0162827), Choi et al. (US 2003/0207585), and further in view of Nallan et al. (US 2002/0137352) and Gabriel et al. (US 6,815,359).

It is noted that Hoefler and Yeh are silent about a fluorine containing gas for cleaning.

Nallan discloses "The use of the fluorine-containing etchant in combination with the more standard chlorine-comprising agent helps remove byproducts from the etch chamber walls, keeping the chamber walls cleaner".

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to further modify the process of Hoefler by adding CF₄, NF₃ or SF₆ because Nallan teaches such mixtures are effective in removing byproducts from the etch chamber walls, keeping the chamber walls cleaner. One of ordinary skill in the art would have been motivated to add CF₄, NF₃ or SF₆ in order to accelerate chamber cleaning when the chamber wall deposit contains silicon.

Yeh teaches polymer is removed with oxygen and Gabriel teaches "plasma etchant, such as, Cl.sub.2 /HBr-based plasmas for etching silicon-based conductors, Cl.sub.2 /BCl.sub.3 -based plasmas for etching metals, C.sub.4 F.sub.8 /O.sub.2 -based plasmas for etching inorganic dielectrics" (column 5, line 67)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to expect the chamber deposits to contain BO_x when the etched top conductor is a metal because Gabriel teaches BCl₃ is conventionally used for metal conductor etching, and Yeh suggests contaminant deposits are accumulated during etching from the etch process. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to expect BO_x as contaminants when BCl₃ and oxygen are used in the etch/clean processes.

Claim Rejections - 35 USC § 103

4. Claims 8-13, 22-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chow et al. (US 6,872,322) in view of Lui et al. (US 6,566,270), Nakajima et al. (2002/0053674), Choi et al. (US 2003/0207585) and Wolf (Silicon Processing for the VLSI Era, Volume 4- Deep Submicron Process Technology, Lattice Press, 2002, page 11).

Regarding claims 8, 22, 27, the references of Chow, Lui, Choi and Wolf have been discussed above.

Chow discloses a method for plasma cleaning a plasma etching chamber comprising the steps of:

placing a substrate having a first polysilicon layered conductive film and a second conductive film of tungsten silicide over the first conductive film within a chamber (col 11, lines 1-3)

etching the first conductive film and the second conductive film within the chamber

using an etching gas and cleaning the chamber with a plasma generated from Cl₂ or a mixed gas of Cl₂ and a fluorine-based gas after the first conductive film and the second conductive film have been etched, etching the second conductive film within the cleaned chamber by repeating the etching step (col 10, lines 52-57; col 11, lines 1-20; fig. 3).

It is noted that Chow discloses the use of dummy wafers/substrates for seasoning the chamber, however, it is noted that Chow is silent about using a second substrate which is not to form a device conventionally known as a dummy substrate for cleaning the chamber.

Lui discloses dummy substrates are conventionally used for etch chamber cleaning (column 1, line 33).

Chow discloses forming a silicon oxide layer under the polysilicon and tungsten layers (col 8, lines 15-17). The oxide layer of Chow is a gate oxide deposited on top of a semiconductor film which forms the channel underneath the gate, as anyone with ordinary skill in the art would know that the semiconducting channel is formed on a "first" substrate. It is noted that Chow is silent about the formation of the transistor channel including the oxide layer being deposited on a conductive layer, however Wolf teaches p-wells or n-wells are conventionally used in device formation see figure 1-7 of Wolf (page 11). One of ordinary skill in the art would have been motivated to use p-wells or n-wells in order to form a twin-well CMOPS structure as suggested by Wolf.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Chow to use a dummy substrate because dummy substrates are conventionally used for etch chamber cleaning. One of ordinary skill in the art would have been motivated to use a dummy substrate in order to decouple the processes of chamber cleaning from etching when the substrate is sensitive to the cleaning byproducts.

Applicant does not specify what specific kind of etching is performed, it would appear that the chamber cleaning procedure and the etch step of Chow would be effective regardless of whether an insulating layer is present under the conducting layer or not, etching is usually performed on the topmost layer. It would also appear obvious to one of ordinary skill in the art at the time the invention was made that the sequence of layers positioned below the topmost layers of conductive films would not affect the chamber cleaning step since those layers are not exposed to the cleaning environment. Chow teaches the general concept of chamber cleaning for the purpose of increasing etch selectivity by reducing the concentration of unwanted species released from deposits on the chamber walls from a previous etch process performed within the same chamber. It is noted that Chow fails to disclose cleaning includes removing BO_x from an inner surface of the chamber

Ye discloses a method for cleaning a plasma etching apparatus comprising a step of cleaning an inner surface of a chamber with chlorine containing gas to remove BO_x (Table 1)

Since Chow is directed to a step of cleaning a chamber using chlorine containing gas, one skilled in the art at the time the invention was made would have found it obvious to employ Chow cleaning step to remove BO_x from an inner surface of the chamber in view of Ye teaching because Ye discloses that the concept of using the halogenated gas mixture to remove by-products is applicable to semiconductor processing chambers in general (col 6, lines 40-45)

It is noted that Chow is silent about cleaning the chamber between a first shape etching and a second shape etching. This limitation has been addressed above in reference to Choi et al. (US 2003/0207585) and Nakajima et al. (2002/0053674)

As to claim 14, quartz is a well known material used in etch chambers. Chow discloses The enclosed chamber 30 has sidewalls 45 and a bottom wall 50 fabricated from any one of a variety of materials including metals, ceramics, glasses, polymers, and composite materials (column 5, line 25). Glasses include quartz.

Regarding claims 9, 23, Chow discloses using an ICP etching method (col 6, lines 35-40)

Regarding claim 10, 24, Chow discloses that the fluorine gas is CF_4 (col 9, lines 37- 40)

Regarding claims 11, 13, 25, 28, it is noted that Chow is silent about a glass or quartz dummy wafer for the cleaning step, however, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Chow to use a dummy substrate made of any material including glass or quartz which is compatible with the chamber and process chemistry because a dummy wafer is used only during cleaning. One of ordinary skill in the art would have been motivated to use glass or quartz in order to prevent introducing impurities in the chamber since glass or quartz (SiO_2) is conventionally used as a material for material fill or gate material, also quartz is resistant to the cleaning chemistry, and glass or quartz wafers are readily available as dummy wafers.

Regarding claims 12, 26, 27 Chow discloses adding oxygen gas to the cleaning plasma (col 9, lines 37-40) and cites "The present process allows etching of one or more layers on a substrate 25 and simultaneous cleaning of the plasma etching chamber 30 in which the etching process is performed, without stopping the etching process. In one or more of the etch process stages, a cleaning gas is added to the etchant gas in a volumetric ratio selected so that the etching residue formed in any one of the etching stages; or the residue formed in all of the etching stages is substantially entirely removed during the etching process. The etchant gas comprises one or more of Cl.sub.2, N.sub.2, O.sub.2, HBr, or He--O.sub.2 ; and the cleaning gas comprises one or more of NF.sub.3, CF.sub.4, or SF.sub.6. It has been discovered that combinations of these gases provide unique and unexpected etching and cleaning properties" (column 9, lines 1-14). Chow teaches that it has been discovered that combinations of these gases provide unique and unexpected etching and cleaning properties. it would have been obvious to one of ordinary skill in the art at the time the invention was made to remove the etching component of the gas mixture during cleaning step while keeping the cleaning component of the gas mixture.

Claim Rejections - 35 USC § 103

Claims 15-21, 22-28, are rejected under 35 U.S.C. 103(a) as being unpatentable over Hoefer et al. (US 2003/0222306) in view of Yeh et al. (US 2002/0162827)

Nakajima et al. (2002/0053674), Choi et al. (US 2003/0207585) and Suzawa et al. (US 2002/0171085).

Hoeffer discloses "After forming and, optionally, patterning the gate dielectric 32, a conductive layer 34 is deposited by PVD, CVD, ALD, the like or combinations of the above. The conductive layer 34 is formed over both the logic region 21 and the NVM region 23 and portions of the conductive layer 34 will remain in each region after being patterned (e.g. etched). The conductive layer 34 can be any conductive material" (paragraph 0021).

It is noted Hoeffer does not expressly disclose tungsten.

Suzawa teaches tungsten is a conductive material, citing "'Further, in the case where W (tungsten) film is used as the metal layer 1002a, by using a mixture gas of Cl.sub.2 (gas flow rate of 25 sccm) and CF.sub.4 (gas flow rate of 25 sccm) and O.sub.2 (gas flow rate of 10 sccm) or a mixture gas of Cl.sub.2 (gas flow rate of 12 sccm) and SF.sub.6 (gas flow rate of 6 sccm) and O.sub.2 (gas flow rate of 12 sccm) as an etching gas" (paragraph 0039).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Hoeffer to include tungsten as the conductive material and etch it by using Cl.sub.2 (gas flow rate of 12 sccm) and SF.sub.6 (gas flow rate of 6 sccm) and O.sub.2 (gas flow rate of 12 sccm) as an etching gas since the procedure is conventionally used in semiconductor processing. One of ordinary skill in the art would have been motivated to use tungsten in order to obtain a highly conductive film.

It is noted that Hoefler is silent about cleaning the chamber between a first shape etching and a second shape etching, this limitation has been addressed above.

As to claims 7, 24, see rejection of claims 3, 10, further in view of Nallan et al. (US 2002/0137352) above.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1, 2, 5, 7, 8, 9, 11, 12, 29, 30, 32, 50, 51, are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamazaki et al. (US 2002/0048829) in view of Chow et al. (US 6,872,322) Nakajima et al. (2002/0053674), Yeh et al. (US 2002/0162827) and Choi et al. (US 2003/0207585).

Regarding Claims 1, 2, 5, 7, 8, 9, 11, 12, 29, 30, 32, 50, 51, Yamazaki discloses a method for manufacturing a semiconductor device, the method comprising: forming a semiconductor film (101) over a first substrate (100); forming an insulating film (102) over the semiconductor film; forming conductive film(s) (103/104) over the semiconductor insulating film; the conductive layer is etched (paragraph 0012).

It is noted Yamazaki is silent about cleaning a chamber, the cleaning including comprising: placing a second substrate in the chamber, wherein said second substrate is not to form a semiconductor device; filling the chamber with a cleaning gas, said

cleaning gas comprising Cl₂ or a mixed gas of Cl₂ and a fluorine-based gas; and generating plasma from the cleaning gas; placing the first substrate with the conductive film, the insulating film and the semiconductor film in the cleaned chamber; and etching the conductive film(s) in the cleaned chamber.

The references of Chow, Nakajima, Yeh and Choi have been discussed above.

Yeh teaches a conductive etch chamber cleaning method wherein "The method further comprises the step of generating a plasma by applying RF energy to the first and second cleaning process gases, such as oxygen and chlorine gases, If there is a sacrificial substrate (also known as a dummy wafer) positioned on the substrate holder 118 to protect the holder 118 from damage during the plasma cleaning operation, the power applied to the second electrode can be set between about 100 W and about 250W. Thus, the method is feasible at the wafer/waferless condition. The method further comprises the step of evacuating the first cleaning process gas from the chamber 100 between the first and the second time periods while maintaining the plasma" (paragraph 0027).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Yamazaki by including a chamber cleaning step as described by Chow and Yeh because chamber cleaning with a dummy wafer is conventionally used in the art of conductor etch. One of ordinary skill in the art would have been motivated to include a chamber cleaning step as described by Chow and Yeh in order to achieve high yield and maintain throughput as suggested by Yeh. It would have been obvious to one of ordinary skill in the art at the time the invention was

made, willing to accept the additional cleaning time, to perform the chamber cleaning step after each etch step. One of ordinary skill in the art would have been motivated to include a chamber cleaning step after each of the etching steps in order to achieve high yield and maintain throughput as suggested by Yeh.

It is noted that Chow fails to disclose cleaning includes removing BOx from an inner surface of the chamber, this limitation has been addressed above in reference to Chow, Nakajima and Choi.

It is noted that Chow is silent about cleaning the chamber between a first shape etching and a second shape etching. this limitation has been addressed above in reference to Chow, Nakajima and Choi

As to claim 6, quartz is a well known material used in etch chambers. Chow discloses The enclosed chamber 30 has sidewalls 45 and a bottom wall 50 fabricated from any one of a variety of materials including metals, ceramics, glasses, polymers, and composite materials (column 5, line 25). Glasses include quartz.

Claim Rejections - 35 USC § 103

Claims 4, 13, 34, are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamazaki et al. (US 2002/0048829) in view of Yeh et al. (US 2002/0162827), Nakajima et al. (2002/0053674), Choi et al. (US 2003/0207585) ,Chow et al. (US 6,872,322) and further in view of Saito et al. (US 6,221,200).

As to claims 4,13, it is noted that Yamazaki is silent about a glass or quartz dummy wafer for the cleaning step, Saito discloses "In order to solve the above

problems, there was proposed a method which comprises fixing, in a plasma etching chamber, a material resistant to plasma etching as a dummy for a wafer, and generating a plasma in the chamber to remove the deposited silicon, etc. by etching. As the material resistant to plasma etching, usable as a dummy for a wafer, there were studied quartz, silicon carbide, graphite and the like" (column 2, line 5), it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Yamazaki to use a dummy substrate made of any material including glass or quartz which is compatible with the chamber and process chemistry because a dummy wafer is used only during cleaning. One of ordinary skill in the art would have been motivated to use glass or quartz in order to prevent introducing impurities in the chamber since glass or quartz (SiO_2) is conventionally used as a material for gate material, also quartz is resistant to the cleaning chemistry, and glass or quartz wafers are readily available as dummy wafers.

Claim Rejections - 35 USC § 103

Claims 3, 6, 10, 14, 31, 33, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, and 64-84, are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamazaki et al. (US 2002/0048829) in view of Yeh et al. (US 2002/0162827), Chow et al. (US 6,872,322), Nakajima et al. (2002/0053674) and Choi et al. (US 2003/0207585) and further in view of Nallan et al. (US 2002/0137352) and Gabriel et al. (US 6,815,359).

Yamazaki shows multiple devices are formed on the same substrate (figures 3(A-D)).

It is noted that Yamazaki and Yeh are silent about a fluorine containing gas for cleaning.

Nallan discloses "The use of the fluorine-containing etchant in combination with the more standard chlorine-comprising agent helps remove byproducts from the etch chamber walls, keeping the chamber walls cleaner".

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to further modify the process of Yamazaki by adding CF₄, NF₃ or SF₆ because Nallan teaches such mixtures are effective in removing byproducts from the etch chamber walls, keeping the chamber walls cleaner. One of ordinary skill in the art would have been motivated to add CF₄, NF₃ or SF₆ in order to accelerate chamber cleaning when the chamber wall deposit contains silicon.

It is noted Yamazaki is silent about BOx or etching with BCl₃, this limitation has been addressed above.

As to claims 39, 41, 48, 49, 53, 55, 56, 63, see rejection in view of Saito et al. (US 6,221,200) above.

Claim Rejections - 35 USC § 103

6. Claims 29-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chow et al (US 6,872,322) in view of Ye et al (US 5,756,400) Nakajima et al. (2002/0053674), Choi et al. (US 2003/0207585) and of Lui et al. (US 6,566,270) and

Wolf (Silicon Processing for the VLSI Era, Volume 4- Deep Submicron Process Technology, Lattice Press, 2002, page 11).

7. The references of Chow, Lui and Wolf have been discussed above.

Regarding claims 29, 35, Chow discloses a method for cleaning a plasma etching chamber comprising the steps of:

filling the chamber with Cl_2 and generating plasma from the Cl_2 to clean the chamber (col 11, lines 35-40), a ceiling of the chamber is made of transparent dielectric material, the ceiling is exposed to the inside of the chamber (col 6, lines 29-32; fig. 2), which reads on a exposed part of the chamber is made from quartz, applying a dielectric magnetic field through the ceiling/quartz and the electrode to generate plasma (col 6, lines 30-54), etching residues are adhered to the chamber surface that includes the ceiling/quartz surface (col 11, lines 40-42).

Chow discloses forming a silicon oxide layer under the polysilicon and tungsten layers (col 8, lines 15-17).

Chow discloses forming a silicon oxide layer under the polysilicon and tungsten layers (col 8, lines 15-17). The oxide layer of Chow is a gate oxide deposited on top of a semiconductor film which forms the channel underneath the gate, as anyone with ordinary skill in the art would know that the semiconducting channel is formed on a "first" substrate. It is noted that Chow is silent about the formation of the transistor channel including the oxide layer being deposited on a conductive layer, however Wolf teaches p-wells or n-wells are conventionally used in device formation see figure 1-7 of

Wolf (page 11). One of ordinary skill in the art would have been motivated to use p-wells or n-wells in order to form a twin-well CMOPS structure as suggested by Wolf.

It is noted that Chow discloses the use of dummy wafers/substrates for seasoning the chamber, however, Chow is silent about using a second substrate which is not to form a device conventionally known as a dummy substrate.

Lui discloses dummy substrates are conventionally used for etch chamber cleaning (column 1, line 33).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Chow to use a dummy substrate because dummy substrates are conventionally used for etch chamber cleaning. One of ordinary skill in the art would have been motivated to use a dummy substrate in order to decouple the processes of chamber cleaning from etching when the substrate is sensitive to the cleaning byproducts. One of ordinary skill in the art would have been motivated to modify the method of Chow by performing cleaning independently of the etching step when the two processes result in undesirable effects on the substrate such as contamination or uncontrollable etch, the method of Chow could obviously be extended to process more delicate substrates, by performing independent etch and clean steps.

Applicant does not specify details of the kind of etching performed in applicant's claim 29, it would appear that the chamber cleaning procedure and the etch step of Chow would be effective regardless of whether an insulating layer is present under the conducting layer or not, etching is usually performed on the topmost layer. It would also

appear obvious to one of ordinary skill in the art at the time the invention was made that the sequence of layers positioned bellow the topmost layers of conductive films would not affect the chamber cleaning step since those layers are not exposed to the cleaning environment.

It is noted that Chow is silent about cleaning the chamber between a first shape etching and a second shape etching. This limitation has been addressed above.

It is noted that Chow fails to disclose cleaning includes removing BOx from an inner surface of the chamber, this limitation has been addressed above.

Regarding claim 30, Chow discloses using an ICP etching method (col 6, lines 35-40)

Regarding claim 31, Chow discloses that the fluorine gas is CF₄ (col 9, lines 37-40)

The limitation of claim 32, have been discussed above, Chow discloses adding oxygen gas to the cleaning plasma (col 9, lines 37-40), fig. 1d of Chow shows an island shaped semiconductor structure is formed.

Regarding claim 33, Chow discloses using a etching gas mixture of Cl₂, SF₆ and oxygen (col 9, lines 36-51)

As to claim 34, the limitation of a quartz dummy wafer has been discussed above.

Claim Rejections - 35 USC § 103

8. Claims 36-42 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lu et al (US 6,352,081) in view Chow et al (US 6,872,322), Choi et al. (US 2003/0207585), Nakajima et al. (2002/0053674), Lui et al. (US 6,566,270), and Wolf (Silicon Processing for the VLSI Era, Volume 4- Deep Submicron Process Technology, Lattice Press, 2002, page 11).
9. The references of Chow, Lui and Wolf have been discussed above.

Lu discloses a method of cleaning processing chamber. The method comprises the steps of:

performing plasma etching using a gas containing BCl₃ as an etching gas in the chamber (col 9, lines 50-55), changing/replacing the etching gas with Cl₂ gas after the plasma etching (col 10, lines 60-65), generating plasma from the Cl₂ (col 10, lines 63- 65), the chamber includes a quartz exposed to the inside of the chamber (col 7, lines 15-20; fig. 2C)

It is noted that Lu is silent about a conductive film.

Chow discloses forming a conductive film, a silicon oxide layer under the polysilicon and tungsten layers (col 8, lines 15-17).

Chow discloses forming a silicon oxide layer under the polysilicon and tungsten layers (col 8, lines 15-17). The oxide layer of Chow is a gate oxide deposited on top of a semiconductor film which forms the channel underneath the gate, as anyone with ordinary skill in the art would know that the semiconducting channel is formed on a "first" substrate. It is noted that Chow is silent about the formation of the transistor

channel including the oxide layer being deposited on a conductive layer, however Wolf teaches p-wells or n-wells are conventionally used in device formation see figure 1-7 of Wolf (page 11). One of ordinary skill in the art would have been motivated to use p-wells or n-wells in order to form a twin-well CMOPS structure as suggested by Wolf.

It is noted that Chow discloses the use of dummy wafers/substrates for seasoning the chamber, however, Lu and Chow are silent about using a second substrate which is not to form a device conventionally known as a dummy substrate for chamber cleaning.

Lui discloses dummy substrates are conventionally used for etch chamber cleaning (column 1, line 33).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the modified process of Lu to use a dummy substrate because dummy substrates are conventionally used for etch chamber cleaning. One of ordinary skill in the art would have been motivated to use a dummy substrate in order to decouple the processes of chamber cleaning from etching when the substrate is sensitive to the cleaning byproducts. One of ordinary skill in the art would have been motivated to further modify the method of Lu by performing cleaning independently of the etching step when the two processes result in undesirable effects on the substrate such as contamination or uncontrollable etch, the method of Lu and Chow could obviously be extended to process more delicate substrates, by performing independent etch and clean steps.

Applicant does not specify details of the kind of etching performed in applicant's claim 36, it would appear that the chamber cleaning procedure and the etch step of Lu and Chow would be effective regardless of whether an insulating layer is present under the conducting layer or not, etching is usually performed on the topmost layer. It would also appear obvious to one of ordinary skill in the art at the time the invention was made that the sequence of layers positioned below the topmost layers of conductive films would not affect the chamber cleaning step since those layers are not exposed to the cleaning environment.

Regarding claim 37, Lu discloses using an ICP etching method (col 8, lines 42-45)

Regarding claims 38-39, 41, Lu discloses that the fluorine gas is CF₄ (col 8, lines 49- 50), using a quartz plate in the chamber (col 8, lines 46-48)

Regarding claim 42, Lu discloses adding oxygen gas to the cleaning plasma (col 10, lines 62-64)

Claim Rejections - 35 USC § 35 USC § 103

10. Claims 43-56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chow et al (US 6,872,322) in view of Lui et al. (US 6,566,270) Nakajima et al. (2002/0053674), Choi et al. (US 2003/0207585) and Wolf (Silicon Processing for the VLSI Era, Volume 4- Deep Submicron Process Technology, Lattice Press, 2002, page 11).

11. The references of Chow, Lui and Wolf have been discussed above.

Regarding claims 43- 48, the reference of Chow has been discussed above, it discloses manufacturing a semiconductor device by forming a semiconductor film over a substrate, and a conducting film (comprising at least two conductive layers)over the semiconductor film (Column 8, lines 8-18). Chow discloses cleaning the chamber with Cl₂, N₂, CF₄ and O₂ (column 9, line 40) plasma.

It is noted that Chow is silent about an insulating film between the semiconductor layer and the first conductive layer, however, Chow discloses forming a silicon oxide layer under the polysilicon and tungsten layers (col 8, lines 15-17). The oxide layer of Chow is a gate oxide deposited on top of a semiconductor film which forms the channel underneath the gate, as anyone with ordinary skill in the art would know that the semiconducting channel is formed on a "first" substrate. It is noted that Chow is silent about the formation of the transistor channel including the oxide layer being deposited on a conductive layer, however Wolf teaches p-wells or n-wells are conventionally used in device formation see figure 1-7 of Wolf (page 11). One of ordinary skill in the art would have been motivated to use p-wells or n-wells in order to form a twin-well CMOPS structure as suggested by Wolf. It would appear that the etching/cleaning method of Chow would be effective even when an insulating layer is present in the film stack because the cleaning chemistry would react with the chamber walls regardless of the presence or absence of an insulating intermediate layer.

Fig. 1d of Chow shows an island shaped semiconductor structure is formed.

It is noted that Chow discloses the use of dummy wafers/substrates for seasoning the chamber, however, Lu and Chow are silent about using a second substrate which is not to form a device conventionally known as a dummy substrate.

Lui discloses dummy substrates are conventionally used for etch chamber cleaning (column 1, line 33).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the modified process of Lu to use a dummy substrate because dummy substrates are conventionally used for etch chamber cleaning. One of ordinary skill in the art would have been motivated to use a dummy substrate in order to decouple the processes of chamber cleaning from etching when the substrate is sensitive to the cleaning byproducts. One of ordinary skill in the art would have been motivated to further modify the method of Lu by performing cleaning independently of the etching step when the two processes result in undesirable effects on the substrate such as contamination or uncontrollable etch, the method of Lu and Chow could obviously be extended to process more delicate substrates, by performing independent etch and clean steps.

As to claims 50-56, it would have been obvious to one of ordinary skill in the art at the time the invention was made to perform the cleaning after any etching step including the conductive layer first etching step or the second etching step or after the first and second etching step because Chow teaches the concept of intermediate cleaning step and Lui teaches the concept of dummy wafer cleaning step, one of ordinary skill in the art would have been motivated to fine tune a cleaning step using the

teachings of Chow and Lui to enhance the etching characteristics of a layer stack with similar materials by routine experimentation including modifying the cleaning sequence, in order to obtain the best possible results according to the specific layer stack.

Claim Rejections - 35 USC § 103

12. Claims 42, 49, 56, 62, 69 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chow et al (US 6,872,322) in view of Lui et al. (US 6,566,270), Lu et al (US 6,352,081), Izawa et al (US 6,842,658), , Nakajima et al. (2002/0053674), Choi et al. (US 2003/0207585) and Wolf (Silicon Processing for the VLSI Era, Volume 4-Deep Submicron Process Technology, Lattice Press, 2002, page 11)

Lu as modified by Izawa has been described above. Unlike the instant claimed invention as per claim 42, 49, 56, 62, 69, Lu and Izawa fails to disclose cleaning includes removing BO_x from an inner surface of the chamber this limitation has been addressed above.

Response to Arguments

6. Applicant's arguments filed 4/16/2009 have been fully considered but they are not persuasive.

Regarding applicant's argument stating that "BO_x is a term that would have been understood by a person of ordinary skill in the art to mean "boron oxide", and it also means that there may be more boron atoms than one", the examiner respectfully disagrees because expressions such as BO_x usually refer to one boron atom (B) and

any (x) number of oxygen (O). The fact that the applicant states that BO_x could read B_2O_3 only emphasizes the fact that the term BO_x is not properly described in the claims and/or specification because the examiner respectfully maintains that B_2O_3 is more conventionally described by the formula B_yO_z where y is an integer of any number greater than zero and z is an integer of any number greater than zero. Applicant did not define what x is or what it can be, in addition, the applicant does not even mention that B could mean B_2 or B_3 or B_y where y is apparently unknown or could take any expression desired by the reader. Therefore, the examiner maintains that the term " BO_x " is not enabling because there is no sufficient direction or guidance in the claim or the specification to determine which " BO_x " is cleaned by the plasma, And that It is not clear what specific compound of the group **$\text{BO}_{\text{sub}x}$ (or BO_x)** is claimed by the applicant since "x" is not defined in the claims or the specification.

As to applicant's argument stating that Choi refers to etching silicon nitride over TEOS and the removal target of cleaning step between the etching steps is nitrogen-containing compounds created after the first etch, the argument is not persuasive because, as stated in the office actions, the examiner relies on Choi only to teach that cleaning chambers between two consecutive etching steps is suggested by Choi to be desirable, and one of ordinary skill in the art of etching would have found it obvious to apply the same cleaning concept between any two or more consecutive etching steps. Motivation to combine the references was provided.

As to applicant's arguments about the grounds of rejection of [Hoeftler et al. (US 2003/0222306) in view of Yeh et al. (US 2002/0162827), Nakajima et al.

(2002/0053674) and Choi et al. (US 2003/0207585)] or [Yamazaki et al. (US 2002/0048829) in view of Chow et al. (US 6,872,322) Nakajima et al. (2002/0053674), Yeh et al. (US 2002/0162827) and Choi et al. (US 2003/0207585)] never suggesting removing BOx, the examiner respectfully disagrees, the combination of the references, in each case, does suggest removing a deposited BOx because the combination of references, in each case, suggests using boron and an oxygen containing gases are used, it is reasonable to expect even minute traces of those elements will remain in the etch chamber and Choi suggests removing deposits from remnant etching chemistries is desirable. The examiner notes that, in at least the independent claims, the applicant does not define what is BOx or even what gases are used for the etching steps, so the examiner interprets that any combination of boron and oxygen obtained from plasma molecular dissociation of any gases containing those element will result in BOx. The applicant did not address to combination of all references in each ground of rejection, but attacked each reference separately. Motivation to combine the references was provided. The applicant did not address why it would not be obvious to combine the references and did not comment on the motivations to combine the references.

Conclusion

7. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within

TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAHMOUD DAHIMENE whose telephone number is (571)272-2410. The examiner can normally be reached on week days from 8:00 AM. to 5:00 PM..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/M. D./
Examiner, Art Unit 1792

/Nadine G Norton/
Supervisory Patent Examiner, Art Unit 1792